

PLANS AND PERMITS REQUIRED FOR OIL AND GAS EXPLORATORY ACTIVITIES

Aerial Photography and photogeologic interpretation may be used to examine geologic, topographic and vegetative patterns that could indicate oil and gas producing formations. This activity occurs early in the investigation process, before the department becomes involved. No permits are required.

Geologic Mapping is normally conducted on foot from existing trails and roads. In remote areas the operation may be supported by pack animal, helicopter or boat. Maps are drawn of geologic features from on-the-ground observations. Areas to be mapped, transportation methods and timing must be described in the Plan of Operations. A Right of Entry permit is required.

Magnetic Surveys are normally conducted from the air. Since no on-the-ground activity occurs, the department imposes no regulations or restrictions.

Gravity Surveys are conducted from aircraft and ground vehicles using existing roads and trails. Surveys done from aircraft are supported by measurements on the ground. Areas to be surveyed, methods, survey stations and timing are described in the Plan of Operations. A Right of Entry permit is required.

Magnetotelluric Exploration and Time-Domain Electromagnetic Soundings normally use existing roads and trails. These surveys cause slight surface disturbances. Location of survey sites, methods and timing of surveys are described in the Plan of Operations. A Right of Entry permit is required.

Geochemical Sampling requires collection of small samples of soil, rock or water using small scoops or soil augers. This may be done along existing roads and trails or on foot. Areas to be surveyed and timing of surveys are described in the Plan of Operations. A Right of Entry permit is required.

Vibratory (or Thumper) Seismic Surveys normally use existing roads and trails. Area, method and timing of surveys must be described in the Plan of Operations. Vibratory surveys are prohibited within 200 feet of Type 1, 2, 3 or 4 waters and wetlands. A Right of Entry permit is required.

Air Shot Surveys (Poulter method) normally use existing trails and roads. In remote areas new trail or road construction may be required. Location, methods and timing of surveys must be described in the Plan of Operations. These surveys are prohibited within a minimum of 200 feet of Type 1, 2, 3 or 4 waters and wetlands. A Right of Entry permit and an environmental checklist is required.

Explosive Seismic Surveys normally use existing trails and roads. In remote areas new trail or road construction may be required. Location, methods and timing of surveys must be described in the Plan of Operations. These surveys are prohibited within a minimum of 200 feet of Type 1, 2, 3 or 4 waters and wetlands. The drilling of the shot-hole (normally less than 200 feet deep) requires a permit from the Oil and Gas Conservation Committee (RCW 78.52.120 and WAC 344-12-050). An environmental checklist is part of the permit application. A Right of Entry permit is required.

Stratigraphic Test Drilling normally uses small (less than one acre) drill pads and existing trails and roads. The drillsite is frequently located along an existing trail or road. Holes are drilled less than 2,000 feet in depth to obtain geologic information on the different strata penetrated. ~~((A Plan of Operations describing location, method, equipment and timing of the activity are required.))~~ A Plan of Operation which includes location, method, equipment, timing and Department of Ecology-approved plans for disposal of drilling fluids and solid wastes, etc., is required. A permit from the Oil and Gas Conservation Committee is required (RCW 78.150.120 and ~~((Gh*))~~ WAC 344-12-050 ~~((WAG)))~~. A supplemental environmental checklist is part of the permit application. A lease is required prior to beginning stratigraphic test drilling. [W11]

Exploratory Drilling requires access road, drill pad construction and disposal of drilling fluid and solid waste. A permit, fees and environmental checklist are requirements of the Oil and Gas Conservation Act (RCW 78.52.120 and WAC 344-12-050). ~~((Exploratory drilling requires an approved Plan of Operations describing location, method, Department of Ecology-approved plans for disposal of drilling fluid, etc.))~~ A Plan of Operation which includes location, method, equipment, timing and Department of Ecology-approved plans for disposal of drilling fluids and solid wastes, etc., is required. A lease is required prior to beginning exploratory drilling. [W11]

PRELIMINARY INVESTIGATIONS

Proposed Action:

Preliminary investigations on department-managed lands will be allowed with a Right of Entry permit. Site-specific conditions may dictate certain restrictions, such as season of operation.

Some preliminary investigations will be prohibited on water and wetland areas.

Alternative:

Preliminary investigations will be prohibited on all department-managed lands.
(No Action)

AERIAL PHOTOGRAPHY

Most oil or gas exploration projects start with a survey of the latest aerial photography available for the area chosen. Besides serving as a base for plotting geologic features, aerial photographs can also be used to pinpoint areas of concern such as game management areas, slide areas, unstable soils, springs or water supplies and depending upon photograph scale, areas of threatened or endangered plants and animals.

Aerial photographs are quite similar to planimetric maps. Their great value lies in portraying a definite and detailed picture of the earth's surface.

A good aerial photograph of an area often serves as the basis for a detailed geologic mapping project since even the most detailed maps do not portray exact renderings of access roads, clearings, streams or topographic features that can be used to locate geologic features in the field. (Compton, 1962.)

In some areas, aerial photographs portray rock units, outcrops and geologic structure so clearly that features can be drawn on the photographs after very little field work by the geologist.

GEOLOGIC MAPPING

Many geologists consider field studies to be the most basic and primary method of generating geologic data. Some studies may be as simple as visiting a single roadcut or quarry, noting and interpreting the geologic features observed and collecting rock samples. On the other end of the spectrum, some detailed projects require months of geologic mapping, careful and systematic sampling, and thorough integration of field and laboratory measurements.

Geologic mapping is so essential to field studies the two terms are often used interchangeably. The mapping function is used to relate data observed at separate outcrops, plot measurements and details of possible oil and gas bearing structures and to permit interpretations of features too large to be studied in

a single rock outcrop. Many oil and gas bearing structures, for example, have been discovered only after integrating sample observations made over an area of tens of square miles. When properly interpreted and presented, geologic maps and supporting data are an excellent means of converting information.

The complement of equipment carried by most field geologists is modest; the basic requirements are usually limited to what can be attached to the belt or carried in a knapsack. Transportation through field areas can be by different modes. For example, many open areas of Eastern Washington can be traversed most efficiently by using pack animal or helicopter for support, while geologic observations in Western Washington's brushy lowlands may require traveling by truck, motorcycle, foot or boat.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The use of aerial photography cannot be denied; thus, the no-action alternative is not applicable.

Environmental impacts attributable to geologic mapping and related field work and observations are considered to be nonsignificant. Prohibiting entry for geologic mapping would afford no further environmental protection.

The department requires approval of a Plan of Operations and a Right of Entry permit before geologic mapping can be done. Before the Right of Entry permit is issued, department staff review the current data file to ensure the activities will not disturb areas containing sensitive plants, wildlife or archaeological features. Appropriate protective measures are determined through consultation with the Natural Heritage Program (DNR), the Nongame Program (WDG) and the Office of Archaeology and Historic Preservation (OAHP).

MAGNETIC SURVEYS

Sedimentary rocks favorable to oil and gas formation are practically nonmagnetic as compared to the deeper "basement" rocks. Magnetic measurements provide patterns of magnetic anomalies from which the spatial extent and thickness of sedimentary deposits can be inferred. A magnetic survey is conducted by aircraft using airborne magnetometers. Such a survey would likely be accomplished by flights at about 1,500 feet in a grid pattern of approximately 3-mile spacing. A survey yielding approximately 2,000 linear miles of magnetic profiles would require about 7 days' flying time if there were no weather delays.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Environmental impacts from airborne magnetic surveys would be limited to the effect of aircraft noise on wildlife and local residents. Airborne magnetic surveys are made over wide areas, irrespective of ownership boundaries.

Mitigation: The only mitigation would be to restrict flights to certain areas. Restricted airspaces are so designated and controlled by the Federal

Aviation Administration (FAA). The Department of Natural Resources may not restrict entry into or through air space above its lands unless it is coincidental with FAA restricted air space. With this exception, there are no mitigative measures for the impacts identified with airborne magnetic surveys.

GRAVITY SURVEYS

Gravity surveys use both ground and airborne equipment, but most airborne surveys also require that supplementary gravity meter readings be taken on the ground. Measurement stations are usually laid out in a grid with spacing from $\frac{1}{2}$ to 3-mile intervals. Gravity-meter readings are taken on the ground by either vehicle- or helicopter-transported crews.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Natural Environment

Earth, Air, Water:

No significant impacts are anticipated.

Plants and Animals:

Environmental impact is limited to the sound and disturbance of gravity crews, survey crews and if used, the helicopter. Helicopter support requires landings at frequent intervals which may crush vegetation and temporarily disturb nearby wildlife.

Mitigation: The technology has recently been developed to conduct gravity surveys entirely from the air. Helicopter-transported gravity surveys may be made using an inertial guidance system, making ground surveying unnecessary. Use of this technique would eliminate the damage to plants and reduce the disturbance to wildlife. The Plan of Operations and Right of Entry permit procedure would condition gravity survey landings.

The alternative that would prohibit gravity surveys would have no impact. However, the impacts of the proposed action are so minimal that such prohibition is unreasonable.

Built Environment

No significant impacts are anticipated.

MAGNETOTELLURIC EXPLORATION

Magnetotelluric (M/T) exploration involves measurement and interpretation of the electrical resistivity of the earth's crust and resistivity changes with depth in a region containing tens of square miles. The resistivity and its changes are

geologically interpreted in terms of rock types and their crustal distribution. The technique and its variations have proven useful in the Columbia Plateau of Eastern Washington where sequences of lava thousands of feet thick make determination of the character of the underlying formations impossible by more conventional geophysical methods. Such an M/T study consists of a series of widely spaced sites which usually fall into a line. Although the theory behind M/T is complex, the exploration method is simple, straight forward and produces minimal impact to the environment.

A typical M/T site is on level ground in loose soil with little or no vegetation for 1,000 feet on each side. Positions for four lead-alloy electrodes are surveyed and staked 90 degrees apart (Figure 4) at each location. A hole 2 feet wide and 2 feet deep is dug at each location. The electrodes are placed in the hole and partially buried. At a separate location, one vertical and two horizontal induction coils are placed in the ground. The vertical coil is placed in the bottom of a 5-inch hand-augered hole 6 feet deep. The horizontal coils are placed in trenches 7 feet long, 6 inches deep and 6 inches wide and separated from each other by at least 6 feet. The coils and electrodes are all connected by surface conductors to a service truck with recording and interpretive capabilities. Recordings are made for 8 to 10 hours at each site. The equipment is then removed, holes are filled and the site returned to original condition.

The M/T method is employed only in remote areas; power lines, telephone lines, electric fences, railroads, freeways and wind blowing through trees are all sources of interference to the very low frequencies being examined.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Natural Environment

Earth:

Only minor disruption of the surface occurs in connection with this technique.

Mitigation: Simple excavation, backfilling and reseeding by the contractor would mitigate any impacts incurred.

The alternative to deny these surveys is unreasonable, since impacts of the proposed action are minimal.

Air, Water:

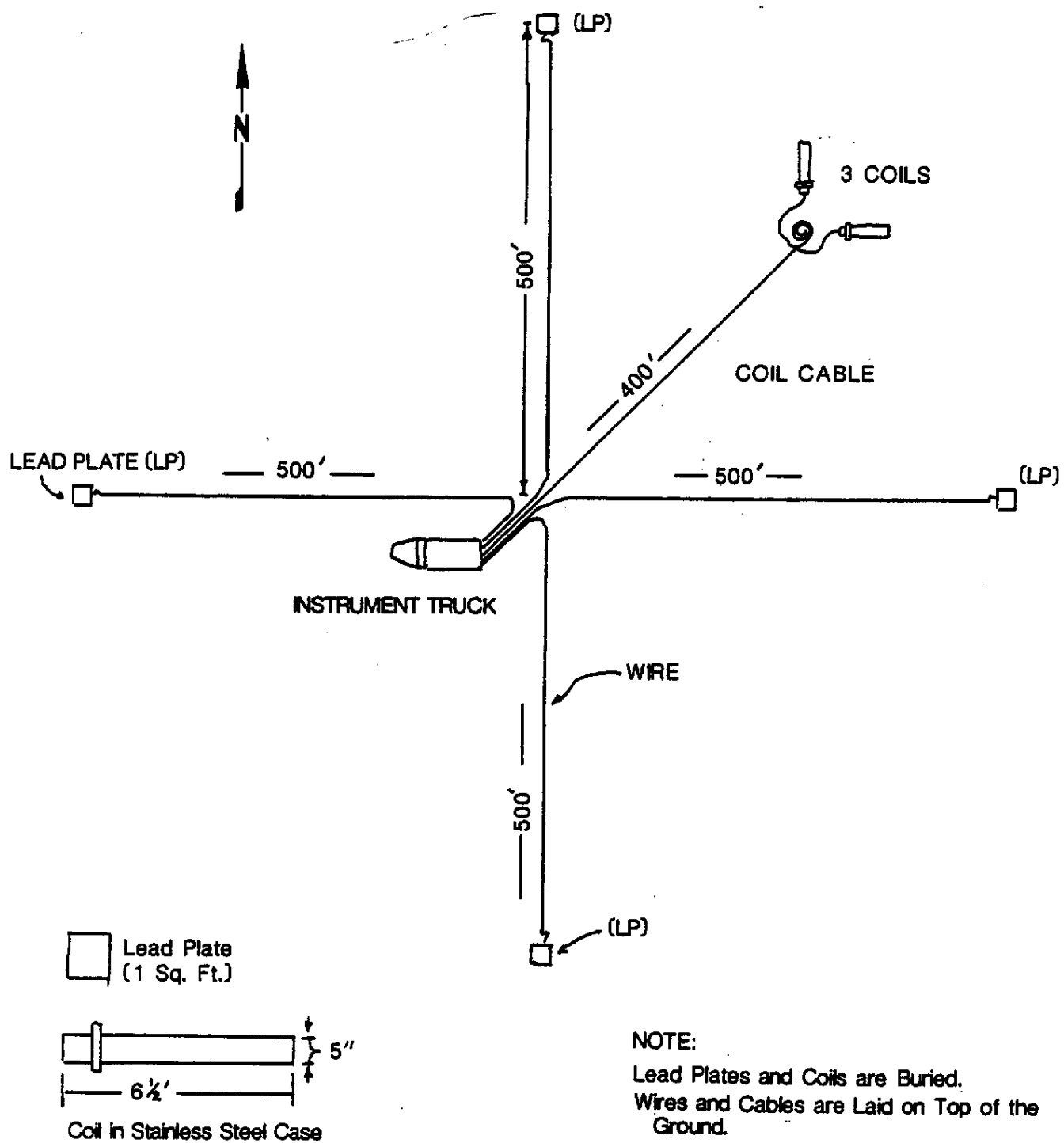
No significant impacts are anticipated.

Plants and Animals:

Some vegetation would be removed and animals disturbed by the presence of the survey team.

Mitigation: Impacts to wildlife would be minimized by coordinating exploration activities so they would not coincide with breeding, nesting or calving

Figure 4. Standard Magnetotelluric Site Layout



Source: C.W. Ruth, 1973.

activities, or wintering areas. The Plan of Operations and Right of Entry permit would stipulate time or area restrictions.

Built Environment

No significant impacts are anticipated.

The alternative would provide no further protection than the mitigated proposed action.

TIME-DOMAIN ELECTROMAGNETIC SOUNDINGS

Time Domain Electromagnetic (TDEM) soundings is not a new geophysical technique. The Russians have been using it for over twenty years, but it hasn't gained popularity in the U.S. yet. TDEM is easier and quicker to record than Magnetotellurics, does less environmental damage, is cheaper per site, and usually produces superior results. The Colorado School of Mines is the only group we know of using the technique presently. The source point is a large, about three miles long, loop of wire which conducts an electrical current produced by a generator. It gives off a magnetic current which is conducted throughout the area tested and read and recorded at many locations. The sounding recording is processed by a complex computer program that models the geologic structure anticipated beneath the test site and compares the model with the actual reading, adjusting the model to both the actual recording and the other recordings taken in the area of interest. After processing, the results are interpreted to provide a 'picture' of the geologic structures, its depth, and its size. (Written communication, David Foley, W. B. Mays and Associates, Ellensburg, WA to Walter Peck, Department of Game, June 22, 1983.)

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Both M/T and TDEM geophysical survey techniques were used on Department of Game lands in Eastern Washington within the last two years. Neither technique was considered by Washington Department of Game personnel to have lasting and significant environmental consequences if simple mitigative measures were employed. Such measures would include reclaiming shallow electrode trenches, keeping vehicles on established roads, policing survey-related trash and avoiding habitat areas in times of breeding or calving. (Walter Peck, Washington Department of Game, personal communication.)

The no-action alternative would eliminate impacts; however, since impacts are minimal, prohibition would be unreasonable.

GEOCHEMICAL SAMPLING

Geochemical sampling, as it applies to petroleum exploration, is a technique whereby soil or rock samples are collected and tested for trace quantities of

oil and gas. Samples may show a higher concentration of these residual fractures than those generally present in the soil, rock vegetation or sediments.

The technique used for soil sampling is uncomplicated and normally requires only simple hand tools. Samples are collected from certain soil horizons using hand-augers or small shovels. Soil sampling programs are usually accomplished on foot using existing trails. The spacing of sample sites will vary, depending upon the intensity of the sampling program. A more ambitious sampling program will operate out of a truck and will be conducted along existing roads.

A project undertaken in northern Yakima county by a major oil company in mid-1984 covered approximately 42,000 acres. One hundred fifty sampling stations were located and sample apparatus placed at each station. Four to five days were required to complete the study. A small hydrocarbon collector the size of a soft-drink can is used at each station; the detection technique is a modern variation of that used in the 1930s and 1940s. (David Foley, W.B. Mays and Associates, personal communication.)

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Natural Environment

Earth, Air, Water:

No significant impacts are anticipated.

Plants and Animals:

Personnel conducting a geochemical sampling program in an area of sensitive plants or critical game habitat could unknowingly destroy or disturb these areas.

Mitigation: Entry to sensitive areas ((would)) will be denied or restricted as conditions of the Plan of Operations and Right of Entry permit. Impacts to wildlife would be minimized by coordinating exploration activities so they would not coincide with breeding, nesting or calving activities or nesting areas. [W18]

Built Environment

No significant impacts are anticipated.

The no-action alternative would have no impacts on the natural or built environment. However, prohibiting surveys would preclude any commercial production of oil and gas in Washington. This would be inconsistent with the goal adopted by the Board of Natural Resources for the Forest Land Management Program to contribute to state energy production. It is also inconsistent with the ((proposed)) goal of the Draft Aquatic Policy Plan to allow suitable state freshwater aquatic lands to be used for energy and mineral production.

SEISMIC EXPLORATION

The principle of seismic exploration is derived from seismology, the geophysical science dealing with earthquakes and related phenomena. Through controlled generation of accoustical energy pulses near the surface of the earth's crust, geophysicists are able to locate geological structures which could contain oil and gas. When these pulses or vibrations strike a layer of rock or other dense material, they divide into three parts: one part returns to the surface as reflected energy; another travels longitudinally along this layer at a greatly increased speed and a portion of it also returns to the surface as refracted energy. The remaining part passes downward and divides repeatedly as it hits new dense layers. Accoustical energy, returning to the earth's surface, is transformed by a series of microphones (geophones) into electrical energy, which in turn is recorded by a seismograph. Recordings yield a seismic section which is translated into an accurate picture of rock layers beneath the surface.

The two methods are illustrated in Figure 5. The refraction method uses the principle that the speed of the shock wave varies according to the elasticity and specific gravity of the rock. Wave speed indicates the depth and type of rock. In the reflection method shock waves are reflected like an echo when they strike a surface boundary between layers of different elasticity and specific gravity. The depth of the reflecting layer can be determined by measuring the time taken for the waves to travel to and from the reflecting layer. The energy source is small and relatively closer to the recording instruments for reflection shooting, while it is larger and farther away for refraction shooting.

A typical operation follows a survey line which transects the area being studied. This survey line would be part of a grid consisting of parallel lines, generally spaced at intervals of 2 to 10 miles, which would intersect and be roughly perpendicular to a second series of lines spaced at similar intervals. Energy would be induced into the earth along these lines at intervals (or multiples) of 220 feet. The reflected energy would be recorded by groups of geophones placed in an array about the energy source. Input from the geophones is collected and recorded. The data are translated and presented graphically. From the graphic information geologic structures are interpreted and decisions are made regarding advisability of stratigraphic or exploratory drilling.

The three most commonly used seismic survey techniques are vibratory (Vibroseis[®]), conventional (or shot-hole) and air-shot (Poulter).

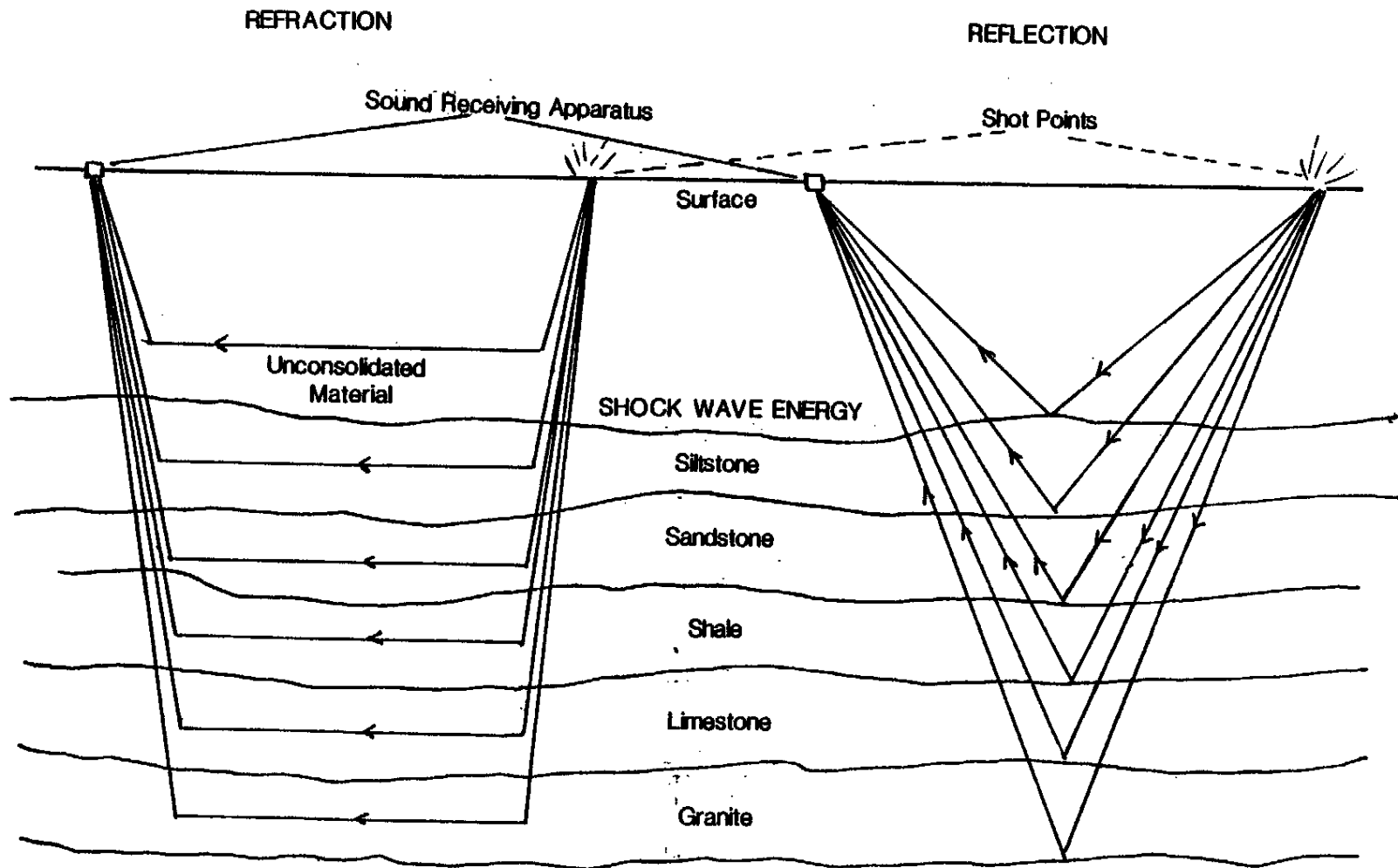
Proposed Action:

Normally, all seismic exploration methods will be allowed on department-managed lands. However, site-specific conditions may preclude the use of certain methods entirely or limit or modify their use.

Alternative:

All seismic exploration methods will be prohibited. (No Action)

Figure 5. Comparison of Refraction and Reflection Shooting



• VIBRATORY SURVEYS

Vibratory surveys (commonly called Vibroseis® - a trademark of Continental Oil Company) have been a frequently used seismic exploration technique in recent years. They are conducted entirely on the surface of the land. Energy is generated into the subsurface by vibrating the surface over a range of frequencies and durations, depending on prevailing noise conditions and energy requirements. The mechanical system is unique in that it is the only system that can control the pulse frequency (vibration) and duration, making it possible to match energy transmission characteristics for best signal returns.

A typical mechanical operation uses the following specialized equipment:

Four wheel-mounted vibrator units, gross weight 45,000 lb., 35,000 pounds on the pad.

One recorder vehicle, gross weight 45,000 lb.

One vibrator tender of similar size and weight to vibrator, gross weight 45,000 lb.

One gravity survey vehicle for data collection and recording.

The number of vehicles used depends on data collection requirements. A typical operation is: The vehicles are arranged in tandem 4 to 5 feet apart at a "source point". The vibrators are lowered to the ground by hydraulic jacks and the weight of each vehicle is applied to the vibrator pad. The vibrators are activated in unison from the recording truck for 20 seconds or less. The trucks are then moved forward for 18 to 24 feet and activated again. The process is repeated 6 to 24 times at each source point. A mechanical survey operation averages 3 to 4 miles daily. The seismic impulses at each source point are recorded via an array of geophones "spread" on the ground and connected to recording instruments in the gravity survey vehicle. The geophone spread runs in a single line 2 to 5 miles long, parallel to the route taken by the survey vehicles.

Because of the bulk and weight of the vehicles, the system is adaptable only to heavy-duty land vehicles and cannot be used in steep or mountainous terrain. The equipment must be used on roads or soils capable of supporting the vehicle weight. [W18]

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Natural Environment

Earth:

Soil compaction at "source points" could result from vibratory operations. In some areas the soil profile may contain large amounts of clay. Under certain conditions, ((some-clays)) these soils exhibit a phenomenon known as liquification when subjected to vibration or shaking. Vibratory operations conducted at the top of steep slopes could cause partial failure, resulting in damage to property or people at the bottom of the slope. [W18]

Mitigation: Remedial measures such as soil scarification and, if necessary, filling cavities and tire marks to original contours will be required in the Plan of Operations.

If vibratory operations are contemplated in areas where unstable clays or soils may be present, the lessee or representative will consult with local ~~((planning-authorities))~~ agencies or authorities with expertise to develop an acceptable Plan of Operations which will bypass areas of unstable soils. [W18]

The alternative (no action) would have no impacts.

Air:

No significant impacts to air quality or climate are anticipated by the proposed action or the alternative.

Water:

No significant impacts to water quality, movement or supply are anticipated for either the preferred action or the alternative. (See Appendix A for further discussion of vibratory survey impacts.)

Plants and Animals:

The significance of impacts to plants and animals will vary with the type and amount of vegetation and species present on a particular area.

Compaction of vegetation could occur. Surveying and support operations could affect vegetation on either side of the seismic line.

Disturbance to animal life could be caused by noise, human and vehicular activity and the use of vibratory equipment. Small mammal habitat in source point areas could be disturbed.

Due to the prohibition of vibratory surveys within 200 feet of Type 1, 2, 3, and 4 waters and wetlands, no significant impact to anadromous fish embryos are anticipated.

Mitigation: In areas of known sensitive plants and animals, the Plan of Operations will specify ~~((minimum))~~ maximum "corridor" widths ~~((required))~~ allowed for passage of survey and support vehicles. The survey operation will remain inside such a corridor until the area of sensitive species has been traversed. Survey and support vehicles may be required to use "flotation" tires in areas where plant survival is critical. Coordination with the Department of Game regional biologist will be required. Measures recommended by Department of Game may be specified in the Plan of Operations. Such measures could include seasonal restrictions or reducing the number of source points. When a vibratory survey is proposed near known spawning areas, a Department of Fisheries or Game Biologist will be consulted and modifications based on Fisheries' or Game's recommendations will be made to the Plan of Operations. [W5, W6, W18]

The alternative (no action) would have no impact.

Energy and Natural Resources:

No significant impacts to nonrenewable or scenic resources are anticipated.

The no-action alternative could inhibit discovery of potential sources of oil and gas, thus reducing the possibility of commercial production for energy uses. (See page 55.)

Built Environment

The no-action alternative would have no impact on the built environment.

Environmental Health:

No significant impacts to environmental health are anticipated. Perceptual impacts may occur. Due to the transitory nature of a Vibroseis survey, these impacts would be of very short duration.

Mitigation: Timing of vibratory survey activities would be arranged to reduce nuisance to human beings. Offsetting distances would be required to reduce impact on structures and wells.

(See Appendix A for a discussion of noise and other impacts of vibratory exploration.)

Land and Shoreline Use:

Vibratory operations in agricultural areas could cause loss of production due to passage of equipment and personnel.

Concentration of activity at source points could leave depressions and ruts which could impede agricultural activities.

Mitigation: The Plan of Operations will stipulate requirements for passage of personnel and vehicles through agricultural areas. Alternate routes using existing roads will be considered. If a roadless traverse is planned, the survey contractor shall provide a waiver of damages or compensation to the surface owner or lessee for damages. The Plan of Operations will require that all land surfaces be returned to original contours.

Transportation:

Local vehicular traffic could be impeded by vibratory equipment and support vehicles.

Mitigation: Timing of vibratory activities would be arranged to reduce activity at peak traffic hours.

Public Services and Utilities:

Roads may be broken or damaged by vibratory surveys and movement of vehicles.

Mitigation: Survey contractors will be required to post a surety for road damages. Survey vehicles will be required to observe state, county and department road restrictions and weight limitations.

• CONVENTIONAL (SHOT-HOLE) SEISMIC

Conventional (shot-hole) seismic refraction and reflection surveys have traditionally used explosive charges as energy sources. An explosive charge is detonated at the bottom of a shallow drillhole; the diameter and depth of the hole, and the size of the charge depend upon local geologic conditions and requirements of the survey. A brief discussion of explosives used by shot-hole contractors and explosive handling requirements are in Appendix B.

The general scheme typical of a shot-hole operation follows. The scheme may be modified in response to survey requirements, climate, topography and time of year. (Northern Geophysical of America, written communication.)

Initial Survey -- A three- or four-person engineering party reconnoiters and surveys the shot-seismic project route. Access routes are flagged and shot-hole and geophone positions are marked for the main seismic crew. Seismic lines are usually surveyed in straight lines to align with the regional trend of the geologic formation being examined. In areas with geographic, topographic or cultural barriers, reflective surveys can tolerate a deviation of up to $\frac{1}{4}$ -mile before the accuracy of the survey will be affected. In a refractive survey, where the seismic line is longer and shot spacing is wider, a deviation of up to one mile is allowable. (USDI, 1981.)

The reconnaissance and survey operations are usually done using one or two four-wheel drive vehicles, road and weather condition permitting. Alternately, equipment and supplies may be transported by foot or horse.

Access and Method -- After the route for the seismic traverse has been surveyed and flagged, access roads are cleared and prepared for use by truck-mounted drilling rigs and support vehicles. Because of increasing expenses associated with seismic surveying, existing roads are followed whenever possible. (F. Tom Ise, Consulting Geologist, personal communication.) In remote areas, roads are built with a minimum amount of earthmoving. In open areas, such as parts of Eastern Washington, road building amounts to removing large rocks and scattered trees. Roadbed preparation is minimal. Roads in Western Washington require more careful attention to construction standards because of soil types and the amount of rainfall. Drill rigs and support vehicles use the same set of tracks which keeps the width of the road to a minimum.

Shot-holes are drilled by truck-mounted equipment, often in a wide spot of the road. The number of drilling rigs used is dependent of the length of the seismic line, the number of holes and the type of survey. Service and water trucks usually accompany the drilling rigs.

Once the shot-holes are drilled, each hole is loaded with an explosive charge and flagged. Drill cuttings, and sometimes gravel, are used to plug the hole directing the energy of the detonation down into the earth instead of up into the atmosphere. Detonation occurs as soon as scheduling of recording equipment allows; however, there may be delays of up to a month. Some shot-holes may be redrilled and shot a number of times to get the best seismic return. After drilling operations are complete, the drilling rigs are removed.

After the drillholes are loaded with explosives, a recording crew arranges pickup cables and geophones along the line of survey. As soon as the recording array is in order, the shots are detonated in a prearranged sequence.

Three examples of shot-hole seismic surveys recently conducted in this state demonstrate the flexibility and wide variation in method and technique. [W18]

- A Shell-Arco joint exploration project in Eastern Washington conducted a seismic reflection survey using 100-foot deep shot-holes. A 15-pound charge was placed in each hole. Access was almost entirely on existing roads. In areas of steep terrain, seismic stations were omitted entirely. (Carl McFarland, personal communication.)
- A seismic refraction survey conducted by the U.S. Geological Survey north of Sunnyside required 8-inch shot-holes drilled to a depth of 140 feet. One ton of explosives was placed in each of four holes. The entire line was 150 miles long. (Edward Criley, USGS, personal communication.)
- An AMOCO Production Company exploration project carried portable drills and back-packed supplies to a reflective survey line in Western Washington. The survey was on forest lands. To preclude damage to the forest, minimal equipment was used. (F. Tom Ise, Consulting Geologist, personal communication.)

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The no-action alternative would have no impacts except those related to locating oil and gas as described in the earlier discussion on page 55.

Road Construction impacts are described in the department's Forest Land Management Program. The Oil and Gas Leasing Program requires conformance with the Road Construction Standards of the Forest Practices Act. (Chapter 222-24 WAC.) These standards were developed to minimize and mitigate road construction impacts on streams and associated resources. Measures described in the Washington Forest Practices Rules and Regulations (Washington State Forest Practices Board, 1982) will be made a part of the Plan of Operations.

Natural Environment

Earth:

Depending on the area traversed by the shot-hole survey crew, soil compaction at drilling points and along access routes could result. Some cratering of the surface could occur, depending on the depth and strength of the explosive charge. The overall degree of impact to soils could be greater than associated with the vibratory method.

Mitigation: Reclamation measures will be prescribed in the Plan of Operations. They may include soil scarification, filling the shot-hole with drill cuttings and gravel and smoothing disturbed areas to original contours to remove most effects of the passage of equipment and detonation.

Air:

Depending on the size and depth of the charge, some dust or gravel may be ejected from the drillhole upon detonation. Some localized odor from the explosive may remain for a short time.

Mitigation: Measures to protect air quality will be determined for each proposed seismic project and made a part of the Plan of Operations. Such measures may include seasonal requirements to compensate for weather patterns. Proximity to population centers and recreation areas will be considered.

Water:

Seismic explosions close to springs and wells may cause changes in water levels or aquifer yield rates.

Mitigation: Buffer areas may be required if the environmental checklist indicates an area of concern. [W11]

Plants and Animals: [W1]

Threatened and endangered plant and animal species may be damaged by the presence of drilling rigs, service trucks and survey personnel.

Depending on vegetative and topographic characteristics of the seismic survey area, debris escaping from the shot-hole could strip leaves and bark from nearby trees or could cover vegetation near the shot-hole.

Resident and migratory animals may be disturbed by the presence of the survey team and equipment. Breeding, nesting, calving and winter ranges may be temporarily disturbed.

Many Washington rivers containing spawning areas (redds) flow through potential oil and gas exploration areas. Anadromous fish embryos could be damaged by acoustic shock generated by seismic exploration activities conducted nearby.

Salmonid embryos are susceptible to damage during a critical period between fertilization and the time the embryo develops eyes (the "eyed" stage). This period begins in November for salmon and in March for steelhead and lasts approximately three to four weeks. Variations in temperature, dissolved oxygen and other factors may advance or retard the attainment of the "eyed" stage. (Paul Hickey, Fisheries Biologist, Muckleshoot Indian Tribe, personal communication.)

Salmon redds in the Nisqually River adjacent to an artillery impact area on the Fort Lewis Army Reservation are of concern to federal biologists. (Jim Stevenson, Fish Biologist, personal communication.)

In Alaska, seasonal restrictions are placed on construction and blasting operations in and near river mouths emptying into Prince William Sound until after the salmonid embryos have attained the "eyed" stage. (Brian Allee, Prince William Sound Aquaculture, personal communication.)

Although the effects of underwater explosives on both marine and freshwater organisms is well-documented in the literature, information regarding the effects on anadromous fish redds from standard drilled shot-holes is notably absent. However, since most seismic charges are placed 100 to 150 feet below the surface and will be offset at least 200 feet from any body of water, the department tentatively concludes that seismic exploration conducted under the proposed policy and current laws and regulations will not cause significant damage to anadromous fish spawning areas.

Mitigation: Natural Heritage and Nongame Program data files will be searched. If the presence of sensitive plant or animal species is indicated, Heritage staff will be consulted for appropriate protection measures. Survey routes, timing and duration may be adjusted to reduce impacts. Protection measures will be made a part of the Plan of Operations.

Coordination with local Department of Game managers will be required for proposed operations on lands leased to the Department of Game. Known areas of breeding or nesting will be identified and the seismic survey schedule may be adjusted to accommodate these critical times. [W6, W18]

A minimum of 200 feet is required between exploration activities and Type 1, 2, 3 or 4 Waters. When a seismic activity is proposed near known spawning areas, a Department of Fisheries or Game biologist will be consulted and modifications based on Fisheries' or Game's recommendations will be made to the Plan of Operations. [W6, W18]

Energy and Natural Resources:

Scenic Resources:

Movement and operation of equipment in arid areas may create dust clouds which could temporarily impair visibility.

Mitigation: Dust abatement chemicals such as ESI-BOND® may be applied to roads to reduce dust. More properly known as an environmental stabilizer, ESI-BOND® was used by Weyerhaeuser Company to control ash during operations near Mt. St. Helens. (Neil Wolbert, Wolbert's Spray Service, Tacoma, WA personal communication.) [W18]

In areas of scenic interest, operations may be timed to avoid daylight or peak visitation hours. Hours of operation could be stipulated in the Plan of Operations.

Built Environment

Environmental Health:

Noise:

The report and concussion associated with explosives used in refractive seismic operations may be a source of nuisance and irritation.

Mitigation: Detonation timing will be conditioned by the Plan of Operations. Charge quantity, shot spacing and proximity of population centers will be considered. Movement of equipment and normal operations may be rescheduled to reduce annoyance in populated areas.

Land and Shoreline Use:

Light and Glare:

Schedules may be adjusted to mitigate noise and dust impacts. Switching to night operation may create impacts from lights.

Mitigation: Scheduling would be arranged to most effectively compensate for impacts. Seismic operations are transitory and of short duration.

Historic and Cultural Preservation:

Seismic exploration lines often traverse distances of tens of miles for one survey. They may bisect or parallel historic or archaeological sites.

Mitigation: Prior to approval of the Plan of Operations, the appropriate department Area office(s) will ascertain the location of local archaeological or historical sites. If necessary, adjustments to the proposed route will be made in the Plan of Operations.

Agricultural Crops:

Seismic surveys through an agricultural area may cause some destruction of crops and damage to private roads. Compaction, rutting and cratering may occur.

Mitigation: Before a seismic traverse is allowed to cross department-leased agricultural lands, the contractor will be required to reach an agreement with the surface lessee regarding damages. The Plan of Operations will require that the site be returned as close to original conditions as possible before the contractor will be released from the damage agreement. Damages to crops will be compensated according to terms arranged between the surface lessee and the contractor.

Transportation:

The small amount of vehicular traffic generated by a shot-hole seismic traverse will be insignificant and should be easily absorbed by existing road networks.

Public Services and Utilities:

Solid Wastes:

No significant impacts are anticipated. The Plan of Operations requires removal of all solid wastes before the bond or surety is released.

Other Governmental Services and Utilities:

If seismic exploration is performed in the immediate vicinity of public utility facilities, damages could occur.

Mitigation: Seismic exploration requires a Plan of Operations, SEPA compliance and a permit from the Oil and Gas Conservation Committee. The contractor will be required to establish offsetting distance for seismic exploration in accordance with facility design requirements. [W13]

• AIR-SHOT (POULTER) SURVEY (SURFACE EXPLOSIVES)

The air-shot, or Poulter, technique also employs explosives as an energy source, but detonation occurs on or above the ground surface. A Poulter survey is conducted similarly to conventional surveys.

The general layout and spacing of the geophone spread is similar to those for a vibration or conventional operation. Total length of the spread may be up to 5 miles. A total explosive charge of 30 to 60 pounds is used, divided into 2- to 5-pound packages arrayed about the source point in various patterns. The pattern and size of the charge most effective for a particular area is determined by field conditions. The explosives are attached to stakes approximately 3 feet above ground, or laid directly on the ground if disturbance of the vegetation is not critical. After detonation, cables and geophones are picked up and shuttled forward to the next source point. Average progress along the line is 3 to 4 miles per day. [W18]

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The no-action alternative would have no impacts on the Built Environment. See page 55 for impact on Natural Resources.

Natural Environment

Earth:

Soils:

Air-shot detonations may cause craters in the surface soil. Soil compaction from vehicles will occur if the survey is done off existing roads.

Mitigation: Placing the explosives on stakes will partially reduce the impacts to the soil. Filling and reseeding craters will be a required part of the Plan of Operations.

Air:

No significant impact is anticipated.

Water:

No significant impact is anticipated.

Plants and Animals:

Detonation of explosives during an air-shot survey may strip some foliage from nearby brush and trees.

Sequential open-air detonation of approximately 25 to 50 explosive charges per mile would generate a substantial amount of noise and shockwave energy that would carry for distances up to several miles from the detonation point. Although many species exposed to this technique in the past have been observed to be disturbed only momentarily and, in fact, have reoccupied areas adjacent to Poulter shot lines within a few hours following detonation, there is little scientific evidence as to what extent fish and wildlife resources may suffer from this type of disturbance. (USDI, 1983.)

During certain seasons, many species are engaged in reproductive activity and are at the height of their behavioral sensitivity. The noise and shockwaves associated with Poulter survey detonations would potentially disturb a large number of species.

Mitigation: Air-shot surveys may be restricted to areas of sparse vegetation. The impacts are transitory so this kind of restriction will seldom be used.

Impacts could be substantially mitigated by restricting operations to areas devoid of significant wildlife concentrations. Inasmuch as these areas are constantly changing through the year, many areas would be excluded from exploratory activities for relatively short periods of time. Air-shot activities near known sensitive areas will be coordinated with a Department of Game regional biologist. Durational or seasonal restrictions will be made a part of the Plan of Operations.

Energy and Natural Resources:

No significant impacts are anticipated.

Built Environment

Environmental Health:

Noise:

Sequential detonation of explosive charges along a survey line in areas of human activity will be a temporary annoyance. The degree of impact is determined by size of charge, height of charge above the ground, attenuation by wind and the presence of topographic or vegetative screening.

Mitigation: Because of the potentially objectionable effect of air-shot detonations, use of this technique may be restricted or denied in some areas.

Land and Shoreline Use:

Recreation:

Use of air-shot seismic techniques near recreational areas may diminish the recreational experience.

Mitigation: Use of the air-shot method may be conditioned or denied in certain areas and during certain seasons.

Agricultural Crops:

Passage of survey equipment and detonation of air-shots will damage cultivated lands and will temporarily remove the area from production.

Mitigation: Before operations begin, agreement for damages must be reached with the surface user. This agreement will be made a part of the Plan of Operations.

Transportation:

No significant impacts are anticipated.

Public Services and Utilities:

Parks or Other Recreational Facilities:

See discussion under Land and Shoreline Use - Recreation.

STRATIGRAPHIC AND EXPLORATORY DRILLING

Proposed Action:

Oil and gas stratigraphic and exploratory drilling will be allowed on department-managed lands under the following conditions:

- A valid lease is required and
- The lessee must submit a Plan of Operations for approval by the Oil and Gas Conservation Committee and the department prior to commencement of drilling and obtain a drilling permit. (WAC 332-12-360 and 344-12-050.)

Alternatives:

1. Prohibit oil and gas stratigraphic and exploratory drilling on department-managed lands (No Action).
2. Allow stratigraphic drilling but prohibit exploratory drilling on department-managed lands.
3. Restrict stratigraphic and exploratory drilling to certain geographic areas.
4. Restrict exploratory drilling to certain geographic areas.
5. ~~Restrict stratigraphic and exploratory drilling in areas with subterranean facilities.~~ [W13]

Discussion

Submission of an environmental checklist and a Plan of Operations for department approval prior to issuing a drilling permit will ensure that an environmental analysis of the site has been made.

The no-action alternative is inconsistent with goals adopted by the department and may reduce the likelihood of discovering commercial quantities of oil and gas. See page 55.

Alternative 2 prohibits exploratory drilling, which would eliminate oil and gas exploration and development in Washington. There would be no incentive to explore if the final phase were prohibited.

Under Alternatives 3, ((and)) 4((,)) and 5 impacts on all elements of the environment would be eliminated in certain predetermined geographical areas. In those areas where drilling would be allowed, the impacts would be the same as the proposed action. The Plan of Operations and permits for allowed drilling require completion of the SEPA process. The difference between the proposed action and the alternative is that the proposed action would prohibit actions on a site-specific basis when the need is determined through the SEPA process. The alternative would make the decision for a much larger area, possibly as an administrative decision rather than through the SEPA process.

STRATIGRAPHIC DRILLING

More precise information on geologic structures and stratigraphy near the surface is often required to corroborate information gained through mapping and geophysical surveys. These data are obtained by drilling one or more stratigraphic drill holes ("strat tests"). Stratigraphic tests are defined in the Oil and Gas Conservation Act as being less than 2,000 feet deep.

Stratigraphic drilling is usually accomplished by a truck-mounted drilling apparatus. A water truck and one or two service trucks may accompany the drilling rig.

Drill cuttings are brought to the surface from the bottom of the hole by high pressure air or drilling mud. The depth at which the cuttings were collected

and the rock-type are identified and their age determined. With this information, a key or "marker" bed within the geologic formation penetrated by the hole can be identified. This identification allows correlation of the structure being drilled to a known geologic structure nearby whose characteristics have already been identified.

Very little road building is presently done in Washington for access to stratigraphic drilling sites. Instead, contractors make use of the extensive network of secondary forest management roads already established to reduce both road construction and reclamation costs. (Carl R. McFarland, Geologist, DNR, personal communication)

Rudimentary clearings are used for stratigraphic drilling; the small scale operation requires approximately 1/3 to 1/2 acre. The mud pits are self-contained and portable. Depending upon the drilling condition of the strata penetrated, stratigraphic tests usually require three to seven days of drilling time. After the test is completed the drill hole is plugged and the area reclaimed.

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Natural Environment

Earth:

Soil compaction may occur due to movement of machinery and support vehicles.

Mitigation: Compacted soils will be scarified and reseeded as part of the reclamation requirements of the Plan of Operations. The size of the truck on which the drill rig is mounted encourages use of drilling locations on wide shoulders and turn outs of secondary roads and small clearings. Such use will be encouraged in the Plan of Operations.

Air:

No significant impact to this element is anticipated.

Water:

Surface Water Quantity: [W18]

Surface water may be required to cool drilling and auxiliary equipment, for make-up of drilling fluid and for potable water. Small amounts of surface water may be used for cooling power plants, generators and wash-down purposes.

The amount of surface water necessary as a base for drilling fluid is dependent upon depth and diameter of the drill hole and the physical and chemical make-up of the geologic strata encountered during drilling. Surface water requirements may vary from several gallons per minute during normal operations, to 100 or more gallons per minute for brief periods if circulation of drilling fluid is lost.

Depending upon proximity of water sources, water for the drilling operation may be hauled or piped from a stream or surface body of water. In some instances, water levels will be lower or flows reduced.

Mitigation: Withdrawal from surface water sources requires a permit from the Department of Ecology.

Surface Water Quality: [W4, W5]

Quantities of water produced in the drilling process may require disposal into a stream or surface body of water.

Mitigation: Surface disposal of water produced during drilling operation must be consistent with Water Pollution Control Act standards. Water protection procedures, as prescribed by the Oil and Gas Conservation Act (WAC 344-12-080), and Department of Ecology regulations (Chapters 173-216 and -303 WAC) will become part of the site-specific Plan of Operations.

The SEPA and Sensitive Area Planning processes may determine that lands containing public water sources will not be leased. [W14, W15]

Runoff/Absorption: [W4]

Exploratory drilling itself will not impact runoff. Spills or leakage from stored bulk drilling mud materials may be absorbed and concentrated in the underlying soil.

Mitigation: Storage of bulk drilling mud materials will be done only in an approved area. The storage site will be surfaced with an impermeable cover. A containment berm surrounding the storage area will be required. Muds designated dangerous waste (Chapter 173-303 WAC) may require special handling on-site.

Ground Water Quality:

Drilling may allow communication between aquifers of different water quality. Quantities of brine may be produced in the drilling process.

Mitigation: Proper aquifer protection procedures as prescribed by the Oil and Gas Conservation Act (WAC 344-12-080), Department of Ecology regulations (Chapter 173-160 WAC) and other local regulations will become part of the site-specific Plan of Operations. These requirements include sealing off strata and cementing well casings. [H3, W11, W16]

Brine must be disposed of consistent with DOE standards, which require injection into an aquifer of equal or lesser quality or may require special handling on-site or while in transit, and disposal in a designated area approved by DOE. [W4, W16]

The SEPA and Sensitive Area Planning processes may determine that lands containing public water sources will not be leased. [W7, W9, W11, W15]

Plants and Animals:

Crushing or obliteration of vegetation may occur around the drill rig.

Stratigraphic drilling operations may disturb animal breeding, nesting or calving areas for a short time.

Mitigation: Stratigraphic drilling requires a Plan of Operations, SEPA compliance and a drilling permit from the Oil and Gas Conservation Committee. Some damage to vegetation around the drill site will be unavoidable. The drilling contractor will be required to compensate surface lessees for any damages sustained. Reclamation of obliterated areas will be required as a part of the Plan of Operations. Drilling activities in areas identified as critical habitat will be restricted or curtailed on a site- or time-specific basis. Impacts to wildlife would be minimized by coordinating exploration activities so they would not coincide with breeding, nesting or calving activities, or wintering areas. [W1]

Energy and Natural Resources:

No impacts to these elements are anticipated.

Built Environment

Environmental Health:

Noise:

Noise associated with the drilling operation and support vehicles may be a nuisance in populated areas.

Mitigation: Drilling and related activities may be restricted to daylight hours to reduce the nuisance factor. [W11]

Release of Toxic Gases:

Hydrogen sulfide (H₂S) may be encountered in dangerous quantities during drilling.

Mitigation: Hydrogen sulfide detectors are required to be a part of every well drilling rig in areas suspected or known to contain hydrogen sulfide gas. (WAC 334-12-098(2).) See Exploratory Drilling.

Land and Shoreline Use:

Existing Land Use:

Drilling will be restricted or denied as stated in the department's Aquatic Land and Water and Wetlands policies (see pages 14 and 15).

Mitigation: There are no mitigating measures.

Light and Glare:

If round-the-clock operations are conducted, light and glare from illuminated sources may become a nuisance in populated areas.

Mitigation: If light and glare is a nuisance, glare shields may be required on drilling apparatus. Hours of work may be restricted to daylight hours.

Agricultural Crops:

If stratigraphic drilling rigs cross cultivated lands, some crops will be destroyed.

Mitigation: Prior to crossing a planted area, the drilling contractor must reach an agreement with the surface lessee regarding damages. The use of existing roads or tracks will be encouraged whenever possible.

Transportation:

No significant impacts are anticipated.

Public Services and Utilities:

~~((No-significant-impacts-are-anticipated.))~~

Other Governmental Services and Utilities:

If stratigraphic drilling is performed in the immediate vicinity of public utility facilities, damages could occur.

Mitigation: Stratigraphic drilling requires a Plan of Operations, SEPA compliance and a permit from the Oil and Gas Conservation Committee. The contractor will be required to establish offsetting distance for stratigraphic drilling in accordance with facility design requirements. [W13]

EXPLORATORY DRILLING

Within the continental United States, about 1 out of every 16 exploratory (wildcat) wells yield significant production during their life (100,000 barrels of oil or 1 trillion cubic feet of gas). Only about 1 out of every 140 wells produce enough to be considered a financial success (USDI, 1981c). Many upland and aquatic areas in Washington have been identified as containing the geologic requirements for accumulation of commercial quantities of oil or gas. Although over 435 exploratory wells have been drilled in Washington to date, there has been no commercial production. It has been estimated that there has been only one exploratory well for every 200 square miles of favorable area.

If data from geologic mapping, geophysical surveys and stratigraphic tests still indicate favorable structures or formations are present, exploratory drilling is

generally the next step in the evaluation process. A lease is obtained and a Plan of Operations is submitted. It must be emphasized that the decision to drill an exploratory well in Washington requires a commitment of several million dollars and possibly a year's time, with absolutely no guarantee that the final result will be a producing well.

A representative sequence of events followed in drilling an exploratory well follows. First, an access route to the well site must be built. Usually, existing roads are improved as required to withstand heavy-equipment vehicle weights. If a new road must be constructed, it is designed to accommodate heavy load-bearing equipment and almost continuous traffic. Turnouts are required at regular intervals. In uneven or mountainous terrain, cut and fill slopes are necessary. Other factors which could influence road construction are expected duration of drilling activity, availability of water, season, climate and topography. The department may specify a route and design which could serve as access to future timber sales.

At the well site, a drill pad is cleared, graded, leveled and graveled and a reserve mud pit excavated. A pad will cover from two to four acres, depending on topography, slope, drainage characteristics and the permitted depth of the well. Deep wells ((15,000)) (9,000 feet or more) require a proportionately larger site. Most of the larger area is occupied by the larger reserve pit, chemical storage and drill pipe storage.

After the drill pad is finished, the drill rig and support facilities such as equipment storage sheds, office trailers, and sanitary facilities are erected. The large amount of equipment needed for a drill rig is hauled in on flat bed trucks and assembled on the drill pad. For example, the AMOCO well drilled near the Wynoochee River in Western Washington required 72 low-boy semi-trucks and trailers to transport the rig and support facilities (Neil Thurgood, AMOCO Production Company, personal communication).

Once drilling begins, the operation continues 24 hours a day. The duration of drilling operations is influenced by many factors, such as depth, geologic characteristics of the formation, type, size and condition of the drilling rig and difficulties encountered in drilling. An exploratory well may require up to nine months to complete; testing with a smaller "work over" rig could take three to six months longer.

A major concern during the drilling operation is the possibility of a "blowout". A blowout occurs when the pressure of the formation being penetrated exceeds the pressure exerted by the column of drilling mud and there is no time to increase mud weight or actuate the blowout prevention equipment (BOPE). Many wells will give definite warnings that a blowout is imminent and appropriate preventative measures are taken. Exploratory wells in Washington are required by the Oil and Gas Conservation Act (WAC 344-12-092) to have BOPE installed and ready for use until drilling ceases. Statistics compiled between 1970 and 1980 for California wells show that of 24,800 wells drilled, only six blowouts occurred during drilling operations (USDA, 1981).

If commercial quantities of oil or gas are found, the exploratory well will be modified to serve as a production well. Such modifications are strictly controlled by statute.

If the wildcat well does not result in discovery of commercial quantities of oil and gas, the well is plugged and abandoned. The site is reclaimed according to the specifications of the Plan of Operations.

• DRILL PAD CONSTRUCTION AND DRILL RIG ASSEMBLY

ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Road construction impacts are discussed under the policy for Road Construction.

Natural Environment

Earth:

Soils:

Clearing and leveling a drill pad and excavation of the reserve mud pit will remove some or all of the top soil.

The soil will be deliberately compacted to provide a stable base for the drilling rig. The degree of irreversible damage from compaction is dependent on the type of soil encountered on the site. "Bearing strength" of the soil is a determining factor. If sufficient bearing strength cannot be achieved by compaction, pilings will be used to prevent possible rig tip over.

Mitigation: Soil removed will be stockpiled and replaced at the conclusion of operations. Areas of slide-prone soils will be avoided. At the conclusion of operations, the site will be scarified to reverse compaction and the stockpiled topsoil spread on the site. Some permanent compaction is unavoidable.

Topography:

Clearing and leveling the drill site will alter the topography of the local area.

Mitigation: Natural clearings and level areas will be used whenever possible.

Air:

Drill pad construction will create dust. The amount of particulate concentration will depend on weather conditions and soil type. Drill rig construction will dramatically increase traffic and therefore could increase particulates in the air. Drill pad construction and drilling rig assembly normally takes about two weeks, so impacts will be of short duration.

Mitigation: Compliance with local air quality standards will be required. In areas where dust will cause visibility or health problems, dust abatement measures such as sprinkling or use of environmental stabilizers will be required in the Plan of Operations. [W18]

Water:

Depending on soil type, surface permeability and topography, runoff may occur during heavy rainfall. Due to the nature of the operations, runoff may be contaminated with both toxic and nontoxic elements such as oil and sediments.

Mitigation: Site-specific requirements to contain runoff will be part of the Plan of Operations. These may include settling ponds or catchment basins. The Plan of Operations will also require compliance with State Department of Ecology ((water-standards)) regulations (Chapters 173-201, -240, -303 WAC). Water-permeable surfacing on the drill pad may also be required. [W4]

Plants and Animals:

Impacts on sensitive plant and animal species are discussed in the Resource Protection section. See also the discussion in the FLMP EIS (DNR, 1983b) and the Natural Heritage Plan (DNR, 1983c).

Clearing and leveling will destroy existing vegetation.

Animal habitat for several acres will be altered, disturbed or destroyed. Small burrowing mammals with established residency will be impacted most. Larger, more transient animals will have to relocate. During drill rig construction, the large amount of traffic may temporarily increase road kill.

Mitigation: The Plan of Operations will require that drill pads be located to minimize impacts on game breeding, nesting, calving and wintering habitat. Native plants and grasses will be planted on the site at the conclusion of operations. Animals will quickly return to the site and re-establish residency after abandonment. The Plan of Operations may stipulate specific reclamation measures to reduce long-term disruption of habitat. [W1]

Energy and Natural Resources:

Exploratory drilling sites located away from major fuel and lubricant distribution points could temporarily affect local supplies of fuel and lubricants.

Mitigation: Supply procurement will be the responsibility of the operator.

Built Environment

Environmental Health:

Noise: [W11]

Equipment used to clear the drill pad site will create noise. There are two types of noise environments on state lands: (1) those in remote locations, generally inaccessible to the public and influenced by few, if any, human sources of noise; and (2) those closer to human population and subject to various human-generated sound (e.g., traffic, aircraft, trains, industries, and residential uses). Most department-managed lands fall into the first category.

Ambient or background noise levels are commonly 20 to 35 dBA¹ in remote locations. Wind blowing through the treetops, rustling leaves and branches, moving water, rainfall, wildlife and even insects are examples.

Noise level predictions for a particular reception point depend on: 1) noise intensity, 2) distance and barriers between the source and reception point, and 3) weather conditions such as temperature, humidity, wind direction and speed. Because of the complexity of sound propagation, noise level predictions do not consider obstacles or wind. However, varying terrain and the presence of obstacles or barriers would reduce noise levels.

The lowest background level measured on state forest land is 27 dBA. This was in a forest devoid of mechanical or other noise generated by man. Averaging 21 measurements of ambient levels made in "quiet forests" on state land, a value of 34 dBA was determined. (DNR, 1983b.)

WAC 173-60-040 establishes the maximum permissible environmental noise level based on three classes determined by typical uses.

- Class A EDNA - includes residential (single and multiple family), recreation and community services.
- Class B EDNA - involves uses requiring protection against noise interference with speech.
- Class C EDNA - includes economic activities with higher noise levels. The maximum permissible noise level between 7:00 a.m. and 10:00 p.m. in Class A is less than or equal to 55 dBA. The noise limitations are reduced by 10 dBA between 10:00 p.m. and 7:00 a.m.

Noise limitation is established by the Washington State Department of Ecology (Table 1).

Table 1 Noise Limitations Established by Washington State Department of Ecology

<u>EDNA* of: Noise Source</u>	<u>EDNA of Receiving Property</u>		
	<u>Class A</u>	<u>Class B</u>	<u>Class C</u>
Class A [†]	55 dBA	57 dBA	60 dBA
Class B ^{**}	57	60	65
Class C ^{††}	60	65	70

- * Environmental Designation for Noise Abatement.
- † Generally residential areas
- ** Generally commercial areas
- †† Generally industrial areas

Noise levels of typical equipment range from 79 dBA (at 50 feet) for a front loader to 101 dBA for a pile driver. These noise levels are all beyond the DOE limitations. However, DOE exempts noises emanating from temporary construction sites as a result of construction activity except in Class A areas (WAC 173-60-050).

Mitigation: Construction activities will be restricted to daylight hours in Class A areas. Additional work hour restrictions may be imposed by site-specific Plans of Operations. Construction noise is temporary.

Land and Shoreline Use:

Existing Land Use:

Approximately two to four acres are required for construction of a drill pad large enough to accommodate a rig capable of drilling 9,000 feet. Deeper wells require a larger drill pad area because of larger reserve mud pits and material handling areas.

Aesthetics:

Drill pad construction and drill rig assembly may be considered unattractive.

Mitigation: Topographic and vegetative screening may be used in areas where the drill site is obtrusive. These measures may be required as needed in the Plan of Operations.

Agricultural Crops:

Drill pad construction will remove approximately two to four acres of land from agricultural and forest production until the site is abandoned. Farm equipment movement may be impeded or restricted.

Mitigation: Prior to construction the lessee or contractor must reach an agreement on payment for damages. Timber must be appraised and paid for. If the well is nonproductive, the drill site will be returned to its original condition as stipulated in the Plan of Operations.

Transportation:

The site chosen for the drill pad may create local traffic problems. In some areas the drill site may bisect a local road. Moving personnel, equipment and

supplies across the road may cause a temporary hazard and impediment to local traffic. Local recreationists, in particular motorcyclists, may be accustomed to using the area for off-road vehicle riding. Mud pits and sediment ponds may create a hazard.

Mitigation: Caution signs and other warning devices will be used as necessary to warn motorists of hazards. Pits and ponds will be signed and fenced as needed to prevent accidents.

Public Services and Utilities:

Solid and liquid wastes and trash accumulations in the drill pad construction area could pose a health hazard and be an "attractive nuisance".

Mitigation: All wastes generated by drill pad and drill rig construction and assembly will be disposed of in a manner consistent with local ordinances and health regulations.

Range/Forest Fire Hazard:

Clearing of the drill pad site will create brush and slash accumulations that could constitute a fire hazard under certain conditions. Drill sites in high grass range areas also create the possibility of a range fire.

Mitigation: Any rubbish or debris that might constitute a fire hazard must be moved at least 100 feet from the well location (WAC 344-12-095). Site-specific Plans of Operations may require additional fire protection measures. These may include filing a contingency fire plan with the local fire district, stationing fire-fighting equipment on the site and carrying basic fire tools in all equipment.

• DRILLING

The longest lasting phase of the Oil and Gas Leasing Program is exploratory drilling. This phase also evokes the most concern. Impacts involve both surface and subsurface elements of the environment.

Natural Environment

Earth:

No significant impacts are anticipated.

Air:

Emissions from diesel and gasoline engines used to generate electricity will impact air quality in the local area. Dust and emissions from vehicle traffic

will be much less than in earlier phases (see Transportation). Temporary atmospheric inversions could cause dangerous concentrations of emissions.

Mitigation: Normal air movements will disperse emissions. If an inversion occurs, engine operation will be restricted or stopped until normal air patterns return.

Water:

Surface Water Quantity: See earlier discussions for impact and mitigation under STRATIGRAPHIC DRILLING.

Surface Water Quality: See earlier discussions for impact and mitigation under STRATIGRAPHIC DRILLING. [W5, W15]

Runoff/Absorption:

Exploratory drilling itself will not impact runoff. Spills or leakage from stored bulk drilling mud materials may be absorbed and concentrated in the underlying soil.

Mitigation: Storage of bulk drilling mud materials will be done only in an approved area. The storage site will be surfaced with an impermeable cover. A containment berm surrounding the storage area will be required. Muds designated dangerous waste (Chapter 173-303 WAC) may require special handling while on-site or in transit. [W4, W15]

(See ((also)) earlier discussions for impacts and mitigation ((from-drill-pad construction)) under DRILL PAD CONSTRUCTION AND DRILL RIG ASSEMBLY.)

Ground Water Quantity:

Water is required to cool drilling and auxiliary equipment, as part of the drilling fluid and for potable water. Small amounts of water are used for cooling power plants, generators and wash down purposes.

Amount of water necessary as a base for drilling fluid is dependent on depth and diameter of the drill hole and the physical and chemical makeup of the geologic strata encountered during drilling. The amount of water necessary may vary from several gallons per minute during normal operations, to 100 or more gallons per minute for brief periods if circulation of drilling fluid is lost.

Depending upon proximity to established water sources, water for the drilling operation may be hauled or piped in from an outside source. In some instances, a water well may be drilled at the site; if so, quantities of water in local aquifers may be reduced.

Mitigation: Withdrawal of surface or ground water requires a permit from the Department of Ecology. Permission from the local municipality may also be required. [W11]

Ground Water Quality:

Drilling may allow communication between aquifers of different water quality. Quantities of brine may be produced in the drilling process.

Mitigation: Proper aquifer protection procedures as prescribed by the Oil and Gas Conservation Act (WAC 344-12-080), Department of Ecology regulations (Chapter 173-160 WAC) and other local regulations will become part of the site-specific Plan of Operations. These requirements include sealing off strata and cementing well casings. [H3, W9, W11]

Brine must be disposed of consistent with DOE standards, which require injection into an aquifer of equal or lesser quality or may require special handling on-site or while in transit, and disposal in a designated area approved by DOE. [W4, W9, W16]

The SEPA and Sensitive Area Planning processes may determine that lands containing public water sources will not be leased. [W7, W14, W15]

Plants and Animals:

The reserve mud pit and settlement ponds may pose a hazard to some animals and birds, particularly water fowl. They may land on or drink contaminated water. In some areas the drilling rig may obstruct migratory bird flyways. Birds have been killed by flying into the rig.

Noises occurring during operations may frighten animals, however most will have already left the area because of the noise caused by drill pad construction.

Mitigation: The mud pit and settlement ponds may be fenced. Devices to frighten birds may be attached to the drill rig, but they are not always successful. Netting may be used over the mud pit and settlement ponds. Once the drilling operation ceases and reclamation is complete, the animals will likely come back. [W6]

Energy and Natural Resources:

Source/Availability:

Depending on fuel and lubricant requirements and proximity to major distribution centers, demand from the exploration project may reduce local supplies. The majority of potential areas in the state are close enough to bulk distribution plants that long-term shortages are not anticipated.

Scenic Resources:

The presence of the drill rig in certain areas may impair long-range or extended vistas.

Mitigation: Topographic and vegetative screening may help but total reduction of impacts is not feasible.

Siting of drilling locations to offset impacts will be required through the Plan of Operations.

Built Environment

Environmental Health:

Noise:

The primary noise during this phase is from diesel engines and generators associated with drilling rigs. Noise levels varying from 72 to 80 dBA could continue day and night. Under usual operations Washington State ambient noise standards will be violated in Class A EDNAs.

Sharp, short-duration noise impulses will occur when drill bits are changed or sections of drill pipe are added.

Mitigation: Construction activities in Class A EDNAs may be restricted to daylight hours. In areas of noise sensitivity (such as residential areas) generators may be placed in buildings and drilling rigs insulated.

Topographic and vegetative barriers may also be used to deaden noises. [W11]

Release of Toxic Gases or Materials:

Drilling operations may encounter pockets of hydrogen sulfide (H_2S). This gas, with its characteristic smell of rotten eggs, is easily detected long before lethal concentrations are reached. (See Table 2.)

Leaking fuel tanks or coolant reservoirs on power generators may contaminate the soil. Drilling mud in the reserve pit may spill over the containment berm during periods of high precipitation. Blowout of the well will cause a sudden release of mud ((ø*)) and gases or oil into the atmosphere and such substances will be deposited in the immediate vicinity of the drill site. Substances can flow from the well site unless contained. [W9]

Accidental oil or chemical spills may occur during the transport and handling of the materials at the drilling site. [W15]

Mitigation: Present state-of-the-art warning devices give audible and visible indications of H_2S presence in the drilling mud at levels far below human detection. Such warning devices are required in areas where hydrogen sulfide gas is known or suspected (WAC 344-12-098(2)).

Blowout prevention equipment is required by the Oil and Gas Conservation Act (WAC 344-12-092). Regular testing and maintenance are also required.

All stationary engines will have catch-pans or impermeable barriers beneath them to keep contaminants from the soil.

A contingency plan for containment of both mud pit materials and chemicals used in mud control techniques and accidental oil spills will be part of the Plan of Operations. [W15]

A contingency plan for containment of blowout substances will be part of the Plan of Operations. [W9]

Table 2 Hydrogen Sulfide Toxicity.

<u>Concentration</u>	<u>Reactions</u>
10 ppm ¹ = .001%	Normal sense of smell can detect this level of concentration.
20 ppm = .002	Safe for 8 hours exposure.
100 ppm = .01	Sense of smell is killed in 3 to 15 minutes, may sting eyes and throat.
200 ppm = .02	Sense of smell is killed shortly. Stings eyes and throat.

D E A D L Y R A N G E:	
500 ppm = .05	Loss of sense of reasoning and balance, occurs along with respiratory paralysis in 30 to 45 minutes; needs prompt artificial resuscitation.
700 ppm = .07	Victim will become unconscious quickly (15 minutes maximum). Breathing will stop and death results if not rescued promptly: immediate artificial resuscitation required.
1,000 ppm = .10	Unconscious at once.
	Permanent brain damage could result unless promptly rescued.

¹ Parts per million

Land and Shoreline Use:

Existing Land Use:

Drilling will be restricted or denied as stated in the department's Aquatic Land and Water and Wetlands policies (see pages 14 and 15).

Mitigation: There are no mitigating measures.

Population:

Little impact on the state as a whole would occur as a result of exploratory drilling. During the past ten years, a maximum of four exploratory drilling

rigs were in operation during any one year. The cumulative total of all out-of-state personnel involved in such activities, including operators, drilling rig and support personnel, probably did not exceed 50 persons.

Due to a lack of experienced oil drilling personnel in the state labor market, very few local persons are hired during this phase; most positions are filled by out-of-state personnel. Due to the relatively short duration of activities, most do not bring their families. They rely on local motels, hotels and trailer parks for housing. Community facilities near the exploration activities will experience very little impact.

Mitigation: Local residents will be hired as much as possible.

Light and Glare:

Round-the-clock drilling will require the use of quartz-halogen or mercury vapor lights. Glare from these lights could be annoying in residential or recreational areas.

Mitigation: Light and glare from night operations may be reduced by use of topographic or vegetative barriers. Man-made screening may also be required.

Aesthetics:

The presence of the drilling apparatus may be unattractive to some viewers.

Mitigation: Efforts will be made to keep the drill site clean and orderly. If commercial quantities of oil or gas are not found, the drilling apparatus will be removed.

Transportation:

Vehicular Traffic:

Traffic associated with the operation, including supply deliveries, shift changes and the curious, may impede or congest local traffic occasionally. Traffic during the night may be annoying to nearby residents.

Mitigation: Supply traffic may be restricted to nonpeak hours. Local traffic rules and restrictions will be observed.

Public Services and Utilities:

Fire:

Failure of the blowout prevention equipment coincidental with a blowout could release flammable gases into the atmosphere.

Mitigation: Regular maintenance of blowout prevention equipment and careful storage of flammable materials will virtually eliminate the chance of fire. A fire contingency plan will be required in the Plan of Operations.

Solid Waste:

Waste materials generated at the drill site include:

1. Solid waste (cement and drilling mud containers, damaged circulating water and mud pump hosing, damaged drilling rig equipment, e.g. casing, drill rods, tools, etc.);
2. Liquid waste (drilling fluid, oil and grease); and
3. Sanitary wastes.

All solid wastes are collected in closed containers and disposed of at a site approved by the state or local agency responsible for waste disposal operations.

Under normal operating conditions the drilling fluid circulates in a closed cycle and there is no intentional discharge of the fluid. At the termination of drilling activities or during changes in drilling fluid composition, it is sometimes necessary to dispose of some quantities of drilling fluid. The liquid waste is returned by injection under controlled conditions to subsurface strata containing water of equal or poorer quality, subject to approval of the state. Dependent upon local evaporation rates, drilling fluids may be permitted to evaporate from the mud pit or to seep into subsurface layers, if approved. When prescribed by state or local agencies, liquid wastes are collected in closed containers and disposed of at a site approved by DOE. (After drilling is complete, the mud pits are back-filled, covered with top soil, and graded and reseeded in accordance with the intended use of the site. Recovery rate of the reclaimed site is dependent upon local climatic conditions.)

Portable sanitary units are used to accommodate personnel at the site. These wastes are also disposed of off-site at approved locations.

Mitigation: No further mitigation measures are needed.

Other Governmental Services and Utilities:

If exploratory drilling is performed in the immediate vicinity of public utility facilities, damages could occur.

Mitigation: Exploratory drilling requires a Plan of Operations, SEPA compliance and a permit from the Oil and Gas Conservation Committee. The contractor will be required to establish offsetting distance for exploratory drilling in accordance with facility design requirements. [W13]

RECLAMATION [W10]

Reclamation of areas subject to damages through disturbances from activities allowable under the Oil and Gas Leasing Program is mandatory. Reclamation requirements of each lease will consider the site-specific conditions present on each tract. These requirements will be included in the approved Plan of Operations.

Upon completion of permitted activities, the lessee or contractor shall remove all equipment, structures and facilities, unless otherwise approved by the Lands Division and the Oil and Gas Supervisor (WAC 344-12-145). A final inspection will be made of the property to ensure that reclamation measures under the approved Plan of Operations have been followed. Termination of the lease or permit and release of surety is contingent upon acceptance by the Oil and Gas Supervisor of plugging and abandonment of work and acceptance by the department of the quality of reclamation (WAC 332-12-380 and -420).

Reclamation requirements may include (but are not limited to) the following mitigation measures. Reclamation measures unique to a particular area will be outlined in the Plan of Operations as a site-specific requirement.

- Filling, recontouring and replacement of topsoil and revegetation of reserve mud pits and drilling sites
- Obliteration and revegetation of temporary access roads [W18]
- Replanting or compensating the surface lessee or owner for agricultural crops or forest products
- Repairs to bridges, culverts, roads, overpasses, cattleguards and fences
- Scarification of soils compacted or rutted by vehicular movement
- Recontouring and replanting of areas where topography has been modified or vegetation removed
- Disposal of contaminated soils, water and drilling mud in approved dumping areas
- Sealing strata containing noxious or toxic gases
- Cementation of potentially usable aquifers
- Proper plugging and abandonment of stratigraphic test holes, seismic shot-holes or exploratory drill holes
- Replacement of fish, animal or bird habitat destroyed or modified by exploratory activities
- Re-establishment of all or portions of roads and trails [W18]
- Clean up of all trash and debris generated at exploration sites